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THE PARADOX OF LABOR DISCIPLINE WITH HETEROGENEOUS WORKERS

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Abstract: The introduction of "effort inducible" and "no effort" workers into a standard labor discipline model results in a paradox of sorts: if firms/capitalists cannot tell the difference, the predictable reductions in both output and workers compensation lead to an *increase* in profits. The resolution is found in the difference in expected productivities of workers with and without contracts, which creates a reputation effect. When the relative proportions of workers are made variable - the consequence of the acquisition and depreciation of productive skills, and a source of positive feedback - the model exhibits multiple equilibria for plausible parameter values.

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The Paradox of Labor Discipline with Heterogeneous Workers *

1. Introduction

Are there conditions under which firms or capitalists could ever *benefit* from incomplete information about workers' abilities or job-related preferences? Consider a modified Shapiro-Stiglitz (1984) model in which capitalists cannot distinguish between two sorts of workers, those who could (and would, for sufficient incentive) expend some predetermined level of *effective* effort $\bar{e}$, and those who could not.[1] The expected mean productivities of those with and without jobs will then differ in the model's pooled equilibrium, and this difference can be interpreted as the *reputation cost of job loss*. Other things being equal, the existence of such costs increases the punishment value of dismissal, and so shifts the balance of power in labor markets, such that capitalists are sometimes made better off.

This view of reputation is reminiscent of Greenwald's (1987, 325) seminal paper on adverse selection in labor markets, in which firms' efforts to reduce the rate at which their better workers turn over creates an environment in which "workers who change jobs are

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[1] In this context, effort is effective if its expenditure reduces worker welfare *and* produces some minimum level of output.

marked by being part of an inferior group, which lowers their future bargaining power and wages." Greenwald's (1987) explanation is not cast in terms of the effort extraction/moral hazard problem featured in this paper, but the antecedents of the two models - in Greenwald's (1987) case, the Salop (1979) model of turnover costs, and in this case, the Shapiro and Stiglitz (1984) model of labor discipline - are both examples of the efficiency wage hypothesis, as Yellen (1984) and others have underscored. These results will also remind some readers of Levine's (1989, 1990) work on just-cause employment policies in a modified labor discipline model, in which such policies can sometimes increase firms' profits because the negative externalities associated with (over)strict dismissal rules are, in effect, internalized.

To the extent that reputation costs constitute one of the "scars" (Ellwood 1982) of job loss, the calibrated version of the model described here also provides new perspective on the econometric literature on the costs of displacement. Farber (1997) reminds us, for example, that workers sampled in one or more of the biannual Displaced Worker Surveys (DWS) between 1984 and 1992 reported an almost 15 percent difference in earnings, a number that *understates* the long(er) term costs. In an effort to measure some of these costs, Jacobson, Lalonde and Sullivan (1993) constructed a longitudinal data set for Pennsylvania workers, and found that even 24 months after separation, displaced workers earned 30 percent less than before, and that this difference was persistent, a result consistent with Schoeni and Dardia (1996), who studied workers in California, and Stevens (1997), who underscores the importance of multiple job loss. Likewise, Hall (1996) concludes, on the basis of Ruhm's (1991) influential PSID-based estimates, that the present discounted value of the lifetime earnings losses following displacement is equal to 120 percent of the representative worker's average annual earnings.

The next section describes a discrete time model of labor discipline in which a small fraction ϵ of all workers are *never* able to expend effective effort, and draws attention to one of its most important, if paradoxical, features: with the limited information available to firms, total output (income) falls but is *redistributed* so that profits, both absolute and as a share of national income, sometimes rise. The third section characterizes the comparative statics of the model's pooled equilibrium[2] for reasonable parameter values, and concludes that in practice, wages and employment could be sensitive to the presence of such workers.

The existence of "no effort" (hereafter, NE) workers needs to be rationalized, however, and this is the purpose of the fourth section, which endogenizes the proportions of "effort inducible" (EI) and NE workers. In particular, I show that when (a) the NE/EI distinction reflects differences in productive skills, and (b) there is some likelihood that EI workers without jobs will lose these skills, and some likelihood that NE workers with jobs will (re)acquire them, labor markets will exhibit positive feedback and multiple equilibria.

The extended model bears some resemblance to Azariadis and Drazen's (1990) formalization of the notion of a threshold effect in economic development though, as Topel (1999) observes in his review of the literature, the required non-convexities in labor markets can have other sources.[3] Within this framework, the deterioration of skills is a prerequisite for,

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[2] *Effort inducible workers* would prefer to signal this to firms, and firms would prefer to induce self-selection, but whether, and how, this can be done is a current research question - see, for example, Jullien and Picard (1998) and Albrecht and Vroman (1999).

[3] Topel (1999) mentions Becker, Murphy and Tamura's (1990) paper, for example.

but not equivalent to, the existence of reputation costs.[4] The fourth section concludes with an evaluation of the local comparative statics of the model's interior stable equilibrium, with particular attention to the effects of variations in the deskill and reskill rates.

2. Workers, Capitalists and Equilibrium: A Benchmark Model

Suppose that there are $(1-\epsilon)H$ identical and infinite-lived effort inducible or EI workers, each with discount rate θ and within period vNM preferences $u(\omega, e) = \omega - e$, where ω is the real wage and e is effort. At the start of each discrete period, EI workers who are employed must decide whether to expend some minimum effort level $\bar{e}$ or to withhold their labor power, in which case $e = 0$. There is some likelihood d that the absence of effort is detected in each period, and all detected workers are dismissed.[5] Since no EI workers shirk in equilibrium, all EI dismissals violate the just cause principle (Levine 1989). To allow for displacement, layoffs and other turnover, it is also assumed that a proportion q of all workers, EI or NE, who are not dismissed in a particular period will leave or be separated for other reasons.

The incentive condition for EI workers is then determined on the basis of the potential lifetime utilities of those who expend $\bar{e}$ and those who do not, denoted V_1 and V_2

[4] For an alternative view, see Greenwald (1985).

[5] This is less restrictive than first seems: within this class of models, capitalists will *choose* to have harsh dismissal policies. For more details, see Levine (1989) or Matthews (1995).

respectively:

$$V_1 = \frac{\omega - \bar{e} + \theta q V_3}{1 - \theta(1-q)} \tag{1}$$

$$V_2 = \frac{\omega + \theta(d + q(1-d))V_3}{1 - \theta(1-q)(1-d)} \tag{2}$$

where V_3 is the welfare of an unemployed EI worker.[6] EI workers will not withhold effort if $V_1 \geq V_2$ or, from (1) and (2), if:

$$\omega \geq \left\{ \frac{1 - \theta(1-q)(1-d)}{\theta d(1-q)} \right\} \bar{e} + (1-\theta)V_3 \tag{3}$$

When this requirement is (just) met, V_3 will itself be a simple function of V_1 and the likelihood a that unemployed workers are (re)hired at the start of the next period, $V_3 = aV_1/(1 - \theta(1-a)$.[7] Substitution for V_1 in (1) then implies that:

$$V_3 = \frac{a(\omega - \bar{e})}{(1-\theta)(1 - \theta(1-a)(1-q)(1-fd))} \tag{4}$$

[6] To derive the second of these conditions, for example, observe that the likelihood that an EI shirker is separated from the firm that hired her is equal to $d + (1-d)q$, the sum of the probabilities that she is detected d and not detected but leaves for other reasons $q(1-d)$. The likelihood that she remains employed is therefore $1 - (d + (1-d)q = (1-d)(1-q)$, and the application of Bellman's Principle then implies that $V_1 = \omega + \theta[(d + q(1-d))V_3 + (1-q)(1-d)V_1]$ which simplifies to (2). The derivation of (1) is almost identical.

[7] To confirm this, observe that EI job seekers will receive an offer, and therefore V_1, with likelihood a, but θV_3 with likelihood $1 - a$ if current period income and effort are assumed to be zero in the event of an unsuccessful search.

which, after much simplification, allows the incentive conditon (3) to be rewritten as:

$$\omega \geq \left\{ \frac{1-\theta(1-a)(1-q)(1-d)}{\theta(1-a)(1-q)d} \right\} \bar{e} \tag{5}$$

This is a variant of the standard Shapiro-Stiglitz (1984) no shirking condition (NSC) and, as such, exhibits some familiar properties: the incentive that EI workers must be offered is a positive function of a and q, the probabilities of rehire and separation, and an inverse function of the detection rate d.

The difference between this and the usual NSC is that the presence of NE workers influences the likelihood that EI workers will be rehired. If there are N employed workers each period, both EI and NE, and a proportion of these are NE, the total number of workers who will lose their jobs at the end of each period is $[q(1-\pi)+(d+q(1-d))\pi]N$ and, in equilibrium, this must be equal to the number (re)hired at the start of the next.[8] In turn, this implies that $(1-d)(1-q)\pi N$ NE and $(1-q)(1-\pi)N$ EI workers will retain their positions from one period to the next, and that $H-[(1-q)(1-\pi)+(1-q)(1-d)\pi]N = H-(1-q)(1-\pi d)N$ workers, both EI and NE, will be abailable for hire at the start of each period. The common likelihood of rehire a must therefore be:

$$\begin{aligned} a &= \frac{[q(1-\pi)+(d+q(1-d)\pi]N}{H-[(1-q)(1-\pi)+(1-q)(1-d)\pi]N} \\ &= \frac{(\pi d+q(1-\pi d))n}{1-(1-q)(1-\pi d)n} \end{aligned} \tag{6}$$

[8] The likelihood that an employed EI worker loses her position at the end of a particular period is q, while the likelihood that an NE worker does is $d+(1-d)q$. It follows that $(d+(1-d)q)\pi N$ NE workers and $q(1-\pi)N$ EI workers will be subtracted and, in equilibrium, added to the number of employed workers each period.

or the ratio of new hires to (start of period) job seekers, where $n = N/H$ is the employment rate. It then follows that for fixed N, the introduction of NE workers is associated with an *increase* in the likelihood of rehire: $(1-q)\pi d$ more workers are hired[9] each period, and the number of those without work falls the same amount, from $H-(1-q)N$ to $H-[(1-q)(1-\pi)+(1-d)(1-q)\pi]N$.

The increased likelihood of rehire (for fixed N, recall) does not mean that EI workers are able to obtain better terms, however. As demonstrated below, the proportion p of those not employed at the end of each period who are NE will exceed π, the proportion of those with contracts who are, and this reduces the post-displacement value of an EI worker's labor power. In heuristic terms, prospective shirkers must now factor a reputation effect into the punishment value of dismissal, which in turn undermines the bargaining position of EI workers. To formalize this argument, observe first that the likelihood that a particular worker is NE, *conditional on membership in the start of period jobless pool,* will be equal to the ratio of the likelihood that she is NE and jobless to the likelihood that she is jobless, and that this implies that:[10]

$$p = \frac{\epsilon H-(1-q)(1-d)\pi N}{H-[(1-q)(1-\pi)+(1-q)(1-d)\pi]N}$$

[9] This is the difference between the number hired when $\pi = 0$, qN, and the number hired when $\pi \neq 0$, $[q(1-\pi)+(d+q(1-d))\pi]N$.

[10] This condition can also be motivated as the constraint on the total number of NE workers in equilibrium, and a companion to (8), a constraint on the number of NE workers in the jobless pool.

$$
\begin{aligned}
&= \frac{\epsilon H - (1-q)(1-d)\pi N}{H - (1-q)(1-\pi d)N} \\
&= \frac{\epsilon - (1-q)(1-d)\pi n}{1 - (1-q)(1-\pi d)n} \qquad (7)
\end{aligned}
$$

For the number of jobless NE workers to remain constant in equilibrium, a second condition must also be satisfied:[11]

$$
\begin{aligned}
p &= \frac{\pi(d + q(1-d))}{\pi(d + q(1-d)) + (1-\pi)q} \\
&= \frac{\pi(d + q(1-d))}{\pi d + q(1-\pi d)} \qquad (8)
\end{aligned}
$$

Together, the last two conditions define the pair of implicit functions $p = p(n)$ and $\pi = \pi(n)$ with three important properties:

(i) the proportion $p = p(n)$ of those out of work at the start of each period who are NE is a positive function of n, with $p(0) = \epsilon$ and $p(1) = \epsilon(d + q(1-d))/(\epsilon d + q(1-\epsilon d))$

(ii) the proportion $\pi = \pi(n)$ of those employed each period who are NE is also a positive function of n, with $\pi(0) = \epsilon q/(q + (1-q)(1-\epsilon)d)$ and $\pi(1) = \epsilon$, and

(iii) $p(n) > \epsilon > \pi(n)$ for $n \in (0, 1)$

Each of these properties can be rationalized. The third, for example, is consistent with the observation that for each n, the likelihood q that employed EI workers will find themselves

[11] To motivate (8), observe that there are πN employed NE workers at the beginning of each period, of whom $(d+q(1-d))\pi N$ will either be separated, or detected and dismissed, at the end of the same period. Since a proportion p of all those in the (start of period) jobless pool, and therefore of *all* new hires, are NE, it follows that $[\pi(d + q(1-d)) + (1-\pi)q]pN$ NE workers will be hired each period. If these flows are to offset in equilibrium, then (8) must hold.

in the jobless pool at the end of each period is (perhaps much) smaller than the likelihood NE workers will. If the number of EI (or NE) workers who lose their positions and are rehired each period are to offset one another, then the proportion π of employed NE workers each period must be less than the proportion p of job seekers who are also NE. The second follows from the requirement that as n rises, so must the proportion of employed workers who are NE, π, as more of the otherwise NE-abundant pool of job seekers is absorbed. An increase in the proportion p of the jobless pool that is also NE will be associated with the rise in π, however, and this is the intuition for the first.

For purposes of exposition, the labor demand shcedule is made as simple as possible: successive doses of effective labor power are assumed to increase output $\alpha\bar{e}$ units. Because new workers are hired from the jobless pool, however, and a proportion $p(n)$ of these are NE, it follows that the incremental increase in output will instead be $\alpha\bar{e}(1-p(n))$, where individual capitalists treat $p(n)$ as a datum. A pair of representative equilibria, with and without NE workers, are depicted in Figure 1.

[Insert Figure 1 About Here]

For the reasons mentioned above, the introduction of NE workers shifts the incentive condition upward, from NSC_1 and NSC_2, and the labor demand schedule downward, from D_1 to D_2. The new NSC and D schedules intersect at E_2, which means that workers with jobs will earn less, ω_2^* instead of ω_1^*, and there will be fewer jobs. In other words, the existence of NE workers reduces and then redistributes national income from workers to the owners of capital such that, in this case, total profits rise. (If workers are themselves the owners/shareholders of these firms, this will manifest itself as a reduction in household income, but an increase in the proportion of this income collected in the form of dividends, etc.)

Capitalists or firms benefit from the presence of NE workers because of the difference in the productivities of workers with and without contracts: the last worker hired contributes $\alpha\bar{e}(1-\pi(n_2^*))$ output but if, in order to signal dissatisfaction with the terms of her current contract, she withholds her labor power, her *expected* contribution if (when) is detected and dismissed falls to $\alpha\bar{e}(1-p(n_2^*))$. Profits are therefore equal to $\alpha\bar{e}(p(n_2^*)-\pi(n_2^*))n_2^*$

3. Comparative Statics for a Calibrated Benchmark Model

As the previous discussion hints, the comparative statics of NE workers are not difficult to characterize in qualitative terms, but an evaluation of their *practical* importance requires parameter values, some of which are difficult to calibrate. To start with the least controversial choices, the rate of time preference θ and the separation rate q were set equal to 0.95 and 0.15. The former corresponds to a real interest rate of 5.2 percent in the absence of financial market imperfections, and the latter is consistent with the adjusted flow data in Summers and Poterba (1986), but is smaller than the estimate in Abowd and Zellner (1985).[12] In the limiting case with no NE workers, the position of the horizontal MPL schedule determines the wage ω^*, so that $\alpha\bar{e} = 40$ (thousand per annum) seems a reasonable first choice. The values of the detection rate d and normalized cost of effort $\bar{e}$, about which there is much less information, then determine the position of the NSC schedule and therefore the equilibrium unemployment rate u^* and likelihood of rehire a^*. Some trial and error then lead to $d = 0.60$ and $\bar{e} = 5$ as plausible first choices: the values of u^* and a^* are then 4.5 and 76.2 percent, where the latter is equivalent to a mean jobless spell of

[12] On the other hand, it exceeds the displacement rates reported in Farber (1997), which fluctuate between 10 and 16 percent between DWS samples.

16.4 weeks.[13] (For comparison purposes, the median annual wage of full-time workers 16 and over was 30 thousand in 2000, the unemployment rate was 4.0 percent, and the mean jobless spell as 13.6 weeks.[14])

The influence of ϵ, the proportion of NE workers, is summarized in Table 1, which reports the equilibrium values of the aforementioned ω^*, u^* and a^*, as well as π^*, the proportion of workers employed each period who are NE; p^*, the proportion of those in the jobless pool at the start of each period who are NE; and u^*_{EI} and u^*_{NE}, the EI and NE specific jobless rates, for values of ϵ between 0 and 10 percent.

[Insert Table 1 About Here]

It also lists the reduction in output, expressed as a fraction of total output in the limiting $\epsilon = 0$ case, the share of this output that accrues to capitalists/firms in the form of supernormal profits, and the value of R, the reputation effect, measured in thousands of dollars per annum.

The responsiveness of the equilibrium - in particular, both the volume and distribution of output - to variations in ϵ is the most remarkable feature of Table 1. As the proportion

[13] If these numbers are indeed reasonable, the calibrated model is consistent with Juster's (1985) view that for a substantial number of workers, the costs of job-related activities are small.

[14] These data are from the January 2001 issue of *Employment and Earnings*. The mean wages for full-time male and female workers 25 and over, perhaps better reference populations, were 36.4 and 26.8 thousand, respectively.

of NE workers in the labor force rises from 0 to just 2 percent, for example, the wages of employed workers fall from 40 thousand to 37.1, a 7.25 percent reduction. Total output falls much less than this, about 2.4 percent, but capitalists/firms receive 5.5 percent of this reduced income in the form of windfall profits. The overall jobless rate rises, from 4.5 percent to 5.2, and with it, the rate for EI workers, to 4.9 percent, and NE workers, to 18.4 percent, while the likelihood of rehire falls a little bit, from 76.2 percent to 74.5.

The equilibrium values p^* and π^*, central to the the characterization of labor market behavior in this framework, are 7.2 and 1.7 percent, respectively. In other words, when 2 percent of all workers cannot expend effective effort, capitalists/firms soon learn that a little more than 7 percent of all those available for hire each period exhibit this characteristic. It follows that the expected productivities of workers with and without jobs will be $\alpha\bar{e}(1-\pi^*) = 39.3$ and $\alpha\bar{e}(1-p^*) = 37.1$ thousand per annum, which in turn means that the reputation cost of job loss R^* will exceed 2000 dollars per annum, or almost 6 percent of the representative EI worker's wage income. It is this cost that EI workers must factor into their effort decisions.

As the proportion of NE workers is increased to 10 percent, on the other hand, output is reduced (just) 12.1 percent, but the wages of employed workers fall almost 30 percent, from 40 thousand per annum, to 28.6. The overall, EI and NE jobless rates rise to 8.4, 6.7 and 24.0 percent, while the likelihood of rehire falls to 67.7 percent, equivalent to a mean jobless spell of more than five months! The substantial decline in compensation and the smaller rise in EI joblessness suggests that for EI workers, the income effect of NE workers will dominate the *jobs effect* in practice. The values of π^* and p^* are 8.3 and 28.5 percent, consistent with a reputation effect of 8.1 thousand per annum, or almost 30 percent of the EI worker's reduced income.

As alluded to earlier, there are no empirical studies to motivate the choice of both detection rate d and cost of effort $\bar{e}$, so some discussion of robustness is warranted. To this end, Figures 2(a), 2(b) and 2(c) are three-dimensional plots of the wage ω^*, unemployment rate u^* and reputation effect R^* for values of d between 0.30 and 0.90, $\bar{e}$ between 2.5 and 7.5, with $\alpha\bar{e}$ still fixed at 40 and $\epsilon = 0.02$ or 2 percent. (The intervals are the initial choices, plus or minus 50 percent.) Figure 2(a) reveals that once the product $\alpha\bar{e}$ is fixed, variations in either the detection rate or the cost of effort do not have much effect on compensation. As expected, ω^* increases with $\bar{e}$, but for $d = 0.60$, for example, it rises from 36.9 thousand, for $\bar{e} = 2.5$, to just 37.3 thousand, for $\bar{e} = 7.5$. Likewise, for $\bar{e} = 5$, ω^* falls from 38.2 thousand when the detection rate is (just) 30 percent, to 36.2 thousand, when it is 90 percent.

On the other hand, Figure 2(b) implies that the effects on joblessless are more substantial. At one extreme, a low detection rate ($d = 0.30$) and high cost of effort ($\bar{e} = 7.5$) are associated with an unemployment rate of 16.1 percent; at the other, a high detection rate ($d = 0.90$) and low cost of effort ($\bar{e} = 2.5$), with 1.7 percent. Figure 2(c) reveals similar variation in the reputation cost of job loss R^*, from 1.0 thousand ($d = 0.30, \bar{e} = 7.5$) to 3.4 thousand ($d = 0.90, \bar{e} = 2.4$), compared to 2.2 thousand in the benchmark ($d = 0.60, \bar{e} = 5$) case.

The sensitivities of u^* and R^* to variations in d and $\bar{e}$ is cause for some concern, but there is little evidence that the initial parametrization is unrealistic.

4. On the Existence of NE Workers: An Extension of the Benchmark Model

There are at least two broad explanations for the existence of NE workers. The first follows from the observation that unemployed EI workers will sometimes *become* NE. The simplest reason this could occur is that separation causes firm- or sector-specific human capital to be lost, a phenomenon featured in empirical work on displacement since Hamermesh (1987) and Topel (1990). The slow(er) erosion of more portable skills could also produce this transformation. The adverse psychological effects of joblessness are a third possible explanation: Darity and Goldsmith (1996) find, for example, that unemployment is associated with measurable damage to workers' well-being, and that productivity is a function of, among other things, this well-being. In a similar vein, Oswald (1997) finds evidence that joblessness is a source of substantial "non-pecuniary distress." If, in this context, all of these are understood to mean an increase in the likelihood of failure, where failure is understood to mean the expenditure of ineffective and therefore unobservable effort, some workers will then find it rational, in the sense of (3), to withhold effort altogether.

The second explanation turns on the identification of NE workers as those with substantial extra-market opportunities and/or wealth: the better a worker's default position, the smaller the punishment value of dismissal, and therefore the more substantial the incentives that the capitalist/firm must provide to induce the required effort level.

To sketch an extension of the model that incorporates the first of these possibilities, suppose that EI workers are as before, but that NE workers have the vNM preferences $u(\omega, e) = \omega - ke$, where $k > 1$ is such that NE workers will, for reasonable values of ω, choose $e = 0$: NE workers find it (much) more difficult, in other words, to provide effective effort $\bar{e}$. Furthermore, suppose that there is some likelihood z_2 that an unemployed EI worker will become NE after one period, but that a proportion z_1 of employed NE workers will become EI, despite the expenditure of no effective effort. (The second of these is less learning by doing, then, than remembering by observing.) In heuristic terms, z_1 and z_2 are the rates at which workers are *reskilled* and *deskilled*.

Even with attention restricted to pooled equilibria, the characterization of labor market transitions - in particular, the determination of p, π and now ϵ - becomes complicated, as the flow chart in Figure 3 attests.

[Insert Figure 3 About Here]

The requirement that the number of employed EI workers be constant in equilibrium in each period, for example, can be expressed as:

$$a(1-p)S + z_1(1-q)(1-d)\pi N = q(1-\pi)N \tag{11}$$

where

$$S = H - [(1-\pi)(1-q) + (1-d)(1-q)\pi]N = H - (1-q)(1-\pi d)N \tag{12}$$

is the number of those without work at the start of each period, *before* capitalists have replaced lost workers. The derivation of (11) follows a familiar line: of the $(1-\pi)N$ EI workers employed each period, a proportion q will be separated from their jobs, which implies that $q(1-\pi)N$ EI workers will join the jobless pool at the end of the period, which is the right hand side of (11). The number $a(1-p)S$ of EI workers hired from this now swollen pool, the product of the rehire rate a and the stock $(1-p)S$ of EI job seekers, should not be equal to the number separated, however, because a fraction z_1 of the $(1-q)(1-d)\pi N$ of the NE workers employed in the previous period who were neither separated nor dismissed will become EI, and the sum of these two flows is the left hand side.

Likewise, for the numbers of employed NE workers and unemployed EI workers to remain constant from one period to the next, it must be that:[15]

$$apS = [z_1(1-q)(1-d) + (q + d(1-q)]\pi N \tag{13}$$

and:[16]

$$a(1-p)S = q(1-\pi)N - z_2(1-a)(1-p)S \tag{14}$$

It is convenient to replace (11) or, if one prefers, (13) with a linear combination of the two:

$$a = \frac{[(q + d(1-q))\pi + q(1-\pi)]N}{S} \tag{15}$$

which then defines the likelihood of rehire in the modified model.

Substitution for a in (11) then implies that:

$$p = \frac{z_1(1-q)(1-d)\pi + (q + d(1-q))\pi}{(q + d(1-q))\pi + (q + fd(1-q))(1-\pi)} \tag{16}$$

[15] If (11), (13) and (14) are satisfied, then as a matter of addition, the number of unemployed NE workers will also be constant.

[16] The first of these (13) asserts that the number apS of NE workers hired each period must offset the number of NE workers who are either separated and dismissed and the number of NE workers who are neither but become EI at the end of the period. The second requires that the number of EI workers who are hired, and therefore leave the jobless pool, must equal the sum of the number of EI workers who are displaced and the number of EI workers who are deskilled.

This establishes a connection between p, π and the reskill rate z_1 that is, perhaps surprisingly, *not* a function of the total number of workers N employed each period. Substitution for a and S in (14), on the other hand, leads to:

$$z_2 = \frac{pq(1-\pi)N - (1-p)(q+d(1-q))\pi N}{(1-p)(H-N)} \tag{17}$$

Given the likelihoods z_1 and z_2 that workers are reskilled and deskilled, and the number of employed workers N, (16) and (17) determine the proportions p and π that are consistent with flow equilibrium, and (15) then determines the likelihood of rehire a. There is no stock condition for the proportion of NE workers in the entire labor force because ϵ is now determined within the model:

$$\epsilon = \frac{pS + (1-q)(1-d)(1-z_1)\pi N}{H} \tag{18}$$

(As a matter of definition, a proportion p of the number S of job seekers at the start of each period are NE, while the number of NE workers who remain under contract from one period to the next is $(1 - z_1(1-q)(1-d) - (q + d(1-q)))\pi N$ or, after simplification, $(1-q)(1-d)(1-z_1)\pi N$.)

It is still the case that $p > \epsilon > \pi$ for each N, and it is not difficult to show that the values of p and π consistent with (16) and (17) are now *decreasing* functions of N. That is, as the number of employed workers N rises, the proportion π of these who are NE, and the proportion p of start-of-period job seekers who are NE, both fall. To see this, observe that (16) implies that p and π will rise and fall together, and that (17) implies that as both rise, N must fall, and vice versa.

This means that even as the individual capitalist confronts what is to him or her a horizontal MPL schedule, the labor demand schedule for all capitalists now slopes *upward*.

If, as confirmed below, the incentive condition for EI workers retains its basic shape, there will now be three equilibria for reasonable parameter values, two stable and one unstable, as depicted in Figure 4a.

[Insert Figures 4a and 4b About Here]

The positive slope is a consequence of the positive feedback mechanism that is now built into the model: as the volume of employment N increases, the proportion ϵ of NE workers in the labor force now falls as workers who would have otherwise remained NE are reskilled. In turn, this pulls downs the shares π and p of NE workers with and without jobs which is sufficient, under some conditions, to "deconvexify" production.[17]

Viewed from another perspective, each new hire produces positive externalities. A proportion p of new hires will be NE and, of these, a proportion $1 - z_1$ will remain so from this period to the next - even if some, perhaps most, are returned to the jobless pool, some will remain at work. The remainder, a proportion z_1 of new NE hires, will reacquire previous skills at the end of the period, but of these, a proportion q will nevertheless return to the jobless pool at the end of the period, where other firms will hire some of them without what are, in effect, training costs. (The firm will also retain a fraction $1 - q$ of these reskilled workers, and so capture some, perhaps most, of the benefits of reskilling for themselves.)

[17] What difference would diminishing, as opposed to constant, returns to effective labor make? Intuition suggests that the MPL function would then be hump-shaped. For small values of N, the reskill effect should dominate, but as N tends to H, the returns effect should. If so, the essential properties of the model are unaffected.

To derive the effort incentive condition for EI workers, note first that the lifetime utilities V_1^{EI} and V_2^{EI} of workers who were effort inducible at the start of each period remain, *mutatis mutandis*, as described in (1) and (2), so that (3) still constrains the firm's offers to such workers. The calculation of V_3^{EI}, however, the welfare of a (for the moment, at least) EI worker who is unemployed becomes more complicated. The EI worker who is separated from her current employer at the end of a particular period will now receive another offer, and therefore receive V_1^{EI}, a percent of the time, will not receive an offer *and remain EI*, with welfare θV_3^{EI}, with likelihood $(1-a)(1-z_2)$, and, most important, will neither receive an offer nor remain EI (that is, become deskilled) with likelihood $(1-a)z_2$, in which case θV_3^{NE} accrues. It follows, therefore, that:

$$V_3^{EI} = \frac{aV_1^{EI} + z_2(1-a)\theta V_3^{NE}}{1-\theta(1-a)(1-z_2)} \tag{19}$$

To determine the value of V_3^{NE}, the lifetime welfare of NE workers without contracts, note first that such workers will find a position, and receive θV_2^{NE} - not, it should be noted, V_1^{NE}, since NE workers are *assumed* not to expend effective effort, which implies that V_1^{NE} must be less than V_2^{NE} - with likelihood a, but will not find a position, and therefore receive θV_3^{NE}, with likelihood $1-a$. It follows that:

$$V_3^{NE} = \frac{aV_2^{NE}}{1-\theta(1-a)} \tag{20}$$

The value of V_2^{NE} is, in turn, dependent on V_1^{EI}, V_3^{EI} and V_3^{NE}:

$$\begin{aligned} V_2^{NE} = {} & \frac{\omega + \theta z_1[(d+q(1-d))V_3^{EI} + (1-d)(1-q)V_1^{EI}]}{1-\theta(1-q)(1-d)(1-z_1)} \\ & + \frac{\theta(1-z_1)(d+q(1-d))V_3^{NE}}{1-\theta(1-q)(1-d)(1-z_1)} \end{aligned} \tag{21}$$

(The derivation of (21) involves no new complications: the NE worker under contract receives ω in the current period, but there is some likelihood $z_1(d + q(1 - d))$, for example, that she will be reskilled, but either be detected and dismissed, or separated for other reasons, and then receive V_3^{EI} at the start of the next period, and so on.)

Combined, (1), (19), (20) and (21) comprise four linear equations in four unknowns - V_1^{EI}, V_3^{EI}, V_2^{NE} and V_3^{NE} - and the substitution of the solution for V_3^{EI} into the incentive condition for EI workers provides the required modification of (5).

Figure 4a, introduced earlier, depicts representative NSC and MPL schedules in this three equilibrium case. For $z_1 = 0.80$ and $z_2 = 0.10$, for example, and the other parameter values assumed in the previous section, there is a stable equilibrium, at $u_1^* = 5.44$ percent, an unstable one, at $u_1^* = 76.2$ percent, and a second stable corner equilibrium, at $u_3^* = 100$ percent. The last of these is *not* implausible if the model is recast as one with dual labor markets, as in Bulow and Summers (1986). In their model, most of those who do not find work in the primary labor market, defined to be one in which effort is difficult to monitor, are absorbed into the secondary market, in which it is not. The corner equilibrium in this model could therefore be interpreted as one in which (almost) everyone works in the secondary market, rather than one in which no one is employed. This implies that the relative sizes of these two markets are less determinate than sometimes supposed. That is, a given set of preferences, endowments and methods of production are consistent, both in principle and in practice, with either a vibrant or an atrophied high wage sector.

This pattern is reminiscent of the earliest neo-classical models (Solow 1956) of under-development traps, in which the feedback mechanism assumed the form of an intensive production function that was concave for capital-labor ratios below some threshold value, and convex above. Following Azariadis and Drazen (1990) and others, this model identifies the labor market as a source of such non-convexities. In particular, if the volume of primary sector employment falls short of the threshold associated with the unstable equilibrium - for the parameter values assumed here, 23.8 percent of the labor force - the number of workers who would exert effort $\bar{e}$ will be too small for the expected contribution of new hires to exceed the incentive wage for EI workers. If employment then falls, however, still more workers will be deskilled and the expected marginal product of a new hire to *fall* even further and, no less important, faster than the incentive wage. In this environment, a state-sponsored "big push" (Murphy, Shleifer and Vishny 1989), perhaps in the form of public expenditure on primary sector output, is sometimes needed to ensure that employment in this sector reaches critical mass or, to invoke Rostow's (1960) famous metaphor, takes off.

It is important to note, however, that the three equilibrium outcome - in particular, the existence of a stable equilibrium in which some, perhaps most, of the labor force is employed in the primary sector - is *not* assured. If, for example, the reskill rate z_1 remains 80 percent, but the likelihood that a worker is deskilled rises to 40 percent, the relative positions of the NSC and MPL schedules become those pictured in Figure 4b, in which case there will be just one (stable) corner equilibrium, at $u^* = 100$ percent. Under these conditions, there is a permanent collpase of the primary sector. This collapse is a consequence of the increased, and now substantial, likelihood that workers who enter the jobless pool are deskilled: when there are few workers employed in the primary sector, there are numerous NE workers in the jobless pool, and the expected marginal product of a new hire is low, but as the number of workers employed increases, the decrease in the proportion of NE workers is more than offset by the increase in the incentive-compatible wage.

Figure 4b bears a strong resemblance to Mankiw's (1986) representation of financial market collapse, and this is not a coincidence. In Mankiw's (1986) model of adverse selection in credit markets, an extension of Stiglitz and Weiss (1981), a rise in the interest rate is associated with an increase in the riskiness of the pool of borrowers and, under some conditions, there is no interest rate at which the expected rate of return is sufficient for banks to lend. Figure 4b depicts a similar breakdown in a contested labor market: in the presence of adverse selection and endogenous skill formation, there will sometimes be no employment level at which the expected return on a new hire will exceed the wage required to induce effective effort.

It is the (local) comparative statics of variations in the reskill and deskill rates z_1 and z_2 for the stable interior equilibrium that are most relevant in the present context, however. Even when such an equilibrium exists, however, the results are conditional on the choice of parameter values. Consider, for example, an increase in the likelihood that EI workers without (primary sector) jobs are deskilled. On the one hand, this causes the modified MPL schedule to shift downward since, for each N, the proportion p of all workers without such jobs who are NE will increase. Consistent with Figure 3a, this puts downward pressure on both the wage ω^* and N^*. On the other hand, the modified NSC schedule will also shift downward: the EI worker who withholds effort now risks detection, dismissal *and* the possible loss of skills, which increases the cost of job loss for fixed N and reduces the incentive capitalists or firms must provide to induce such effort. This in turn tends to increase the number of workers hired and, because of the positive feedback mechanism embedded in primary sector labor markets, the wage ω^* each worker is offered. The net effects on both ω^* and N^* turn, therefore, on the sizes of these shifts, and these are difficult to predict *a priori*.

To see what these shifts could be in practice, Figures 5(a) through 5(g) are three-dimensional plots of the equilibrium wage ω^*, unemployment rate u^*, likelihood of rehire a^*, proportion p^* of all those not employed (in the primary sector) who are NE, proportion π^* of all those employed who are NE, proportion ϵ^* of NE workers in the labor force as a whole, and last, the reputation effect R^*, for values of z_1 between 0.75 and 1 and z_2 between 0 and 0.35.

[Insert Figures 5a, 5b, 5c, 5d, 5e, 5f and 5g About Here]

(Recall that for values outside these intervals, the stable interior equilibrium is often lost.) For reference purposes, the benchmark values are $z_1 = 0.80$ and $z_2 = 0.10$. In this case, employed workers earn 35.6 thousand per annum, the overall jobless rate is 5.4 percent, the rehire rate is 73.5 percent, equivalent to a mean jobless spell of 18.7 weeks, 11.0 percent of those not employed (in the primary sector) are NE, 1.88 percent of those in it are NE and 2.38 percent of the labor force as a whole is NE. The reputation cost of job loss is 3.65 thousand per annum, or 10.25 percent of the annual wage.

The most striking feature of these diagrams is how sensitive the equilibrium is to variations in the deskill rate z_2. In terms of Figure 4a, it seems that the first of the aforementioned shifts is dominant. Holding the reskill rate z_1 constant at 80 percent, for example, the wage rate ω^* falls from 35.6 to 21.8 thousand as the deskill rate z_2 from 10 to 35 percent. The unemployment rate u^* more than doubles, from 5.4 to 12.2 percent, a rise mirrored in the decreased likelihood of rehire, from 74 to 59 percent, equivalent to an increase in the mean jobless spell from 18.2 to 36.1 weeks. At the same time, the reputation cost of job loss R^* almost *quadruples*, from 3.65 to 14.2 thousand or 65 percent of the (now reduced) wage rate. This in turn reflects a mammoth increase in the proportion of NE workers in the jobless pool, from a little bit more than 10 percent to almost 50 percent. The share of those with (primary sector) jobs who are NE also rises, from 1.88 to 9.76 percent, as does the share of NE workers in the labor force, from 2.38 to 14.1 percent. In the extreme ($z_2 = 0.35$) case, the dramatic difference in the proportions of NE workers with and without jobs means that the worker who withholds effort - that is, contests the exchange of labor power - risks joining a pool whose expected output is almost 16 ($= 36 - 20$) thousand dollars lower.

The net effect of variations in the reskill rate z_1 are also the result of competing, but in this case more or less equal, shifts of the modified NSC and MPL schedules. On one hand, as z_1 rises, the expected reduction in the proportion p of job seekers who are NE for each N causes the labor demand schedule to shift upward, which causes both ω^* and N^* to rise, *ceteris paribus*. On the other, the incentive condition or NSC also shifts upward - the punishment value of dismissal is reduced because the likelihood that workers who lose their jobs but are later rehired (re)acquire lost skills rises, so that the incentve required to induce effort increases, too - which tends to drive ω^* and N^* down. In the calibrated model, these shifts almost offset one another. Holding the deskill rate fixed at 10 percent, for example, the equilibrium wage ω^* increases from 35.4 thousand per annum to just 36.2 thousand as z_1 increases from 0.75 (75 percent) to 1.00. At the same time, the unemployment rate u^* falls just 0.2 percentage points, from 5.5 percent to 5.3, while the rehire rate rises, from 73.3 percent to 73.9. It then comes as no surprise that the proportions of those in the labor force, those with primary sector jobs, and those without such jobs who are NE all fall a little bit as the reskill rate rises, from 2.5, 2.0 and 11.4 percent to 1.9, 1.5 and 9.4 perecent, or that the reputation cost of job loss also falls, but not much, from 3.8 thousand to 3.1.

What are the broader lessons of this exercise? First, that the destruction and reformation of human capital, which macroeconomists often treat as a long run or growth phenomenon, can influence labor market outcomes in the short and medium terms. Second, that within this context, macroeconomists should devote as much attention to the latter as the former: the results presented here indicate that labor market outcomes will be sensitive to the rate at which displaced workers are deskilled.

It is also possible to calculate, for the same combinations of z_1 and z_2, the volume of (primary sector) employment associated with the second or unstable interior equilibrium, taking care not to run afoul of the correspondence principle. (The results are better interpreted in terms of the sector's *minimum viable mass* in different economies, and not as variations in this mass.) The data are plotted in Figure 6.

[Insert Figure 6 About Here]

The data hint that economies with smaller likelihoods of deskilling, or slower human capital depreciation, will have better - that is, more workers will be hired - stable equilibria and smaller viable masses. (Recall that when the deskill rate increases even further, both interior equilibria vanish, leaving just one (stable) outcome in which the primary labor market is collapsed.) Figure 6 also reveals that similar benefits - better stable equilibrium, smaller minimum viable mass - also accrue to economies with high reskill rates.

5. Conclusion

The proposition that the presence of workers unable to expend effective effort will benefit capitalists or firms seems counterintuuitive until it is recalled that in practice, the punishment value of dismissal often includes a reputation cost. If the Shapiro-Stiglitz model is extended to include a small number of such workers, and these workers cannot be distinguished from their effort inducible peers, a reputation effect of sorts emerges in the pooled equilibrium, in the form of a difference in the mean productivities of workers with and without jobs, a variation on Greenwald (1987). With this reputation effect in place, both the number of workers hired and total output will fall, but profits, both in absolute terms and as a share of national income, rise. If the acquisition and deterioration of effective skills is then explicitly modelled, a positive feedback mechanism is established and with it, the existence of multiple equilibria for plausible parameter values. Under these conditions, the stable high employment equilibrium seems to be more sensitive to variations in the rate at which workers are deskilled than reskilled, a result that underscores the importance of recent empirical work on displacement.

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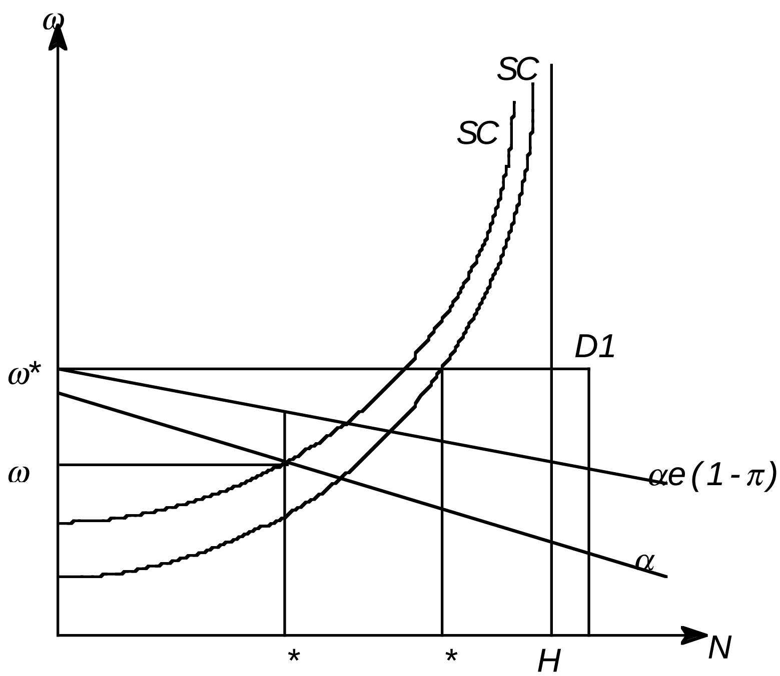

Figure 1: Labor Market Discipline with and without NE Workers

Table 1. The Comparative Statics of NE Workers

	Number of NE Workers, as a Percentage of the Labor Force					
	0	2	4	6	8	10
ω(th)	40.0	37.1	34.6	32.4	30.4	28.6
u	4.5	5.2	5.9	6.7	7.5	8.4
a	76.2	74.5	72.8	71.1	69.4	67.7
p		7.2	13.4	19.0	24.0	28.5
π		1.7	3.4	5.1	6.7	8.3
R(th)		2.2	4.0	5.6	6.9	8.1
Q Loss		2.4	4.8	7.3	9.7	12.1
Profits		5.5	10.4	14.7	18.6	22.0
u_{EI}		4.9	5.3	5.7	6.2	6.7
u_{NE}		18.4	19.8	21.1	22.5	24.0

Notes: All of the variables are as described in the text and, with the exception of compensation ω and the reputation effect R, which are measured in terms of thousands of dollars per annum, are expressed in percentage terms.

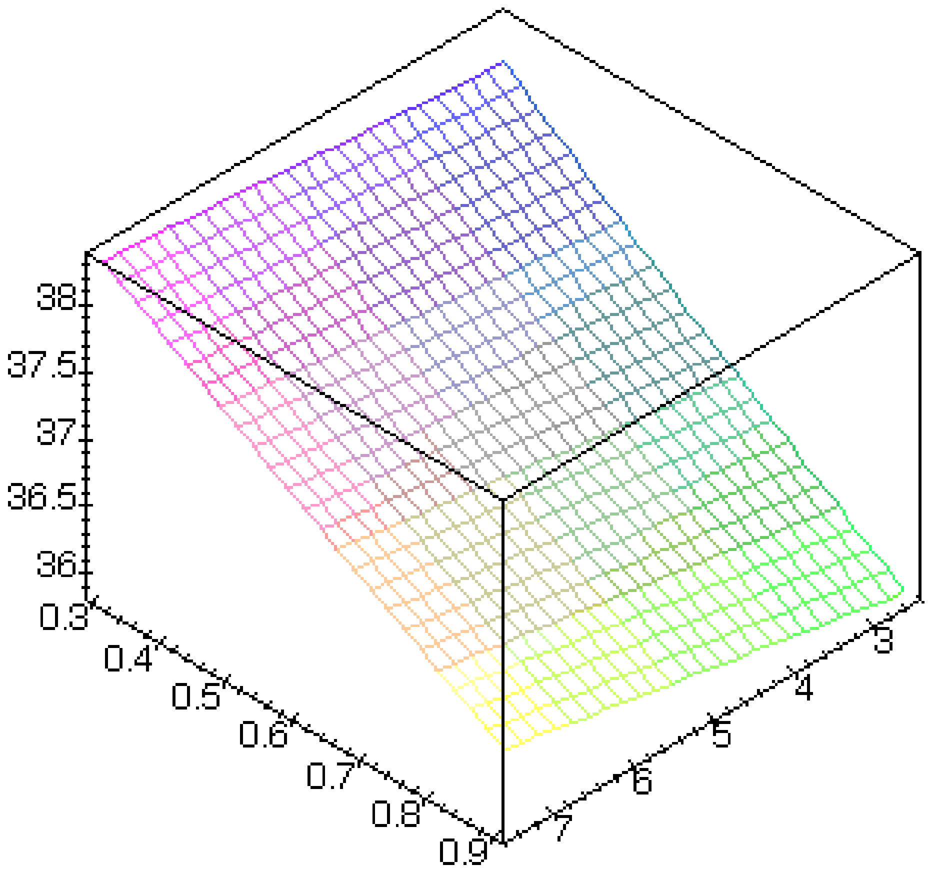

Figure 2a: Wages, Effort Levels and Detection Rates

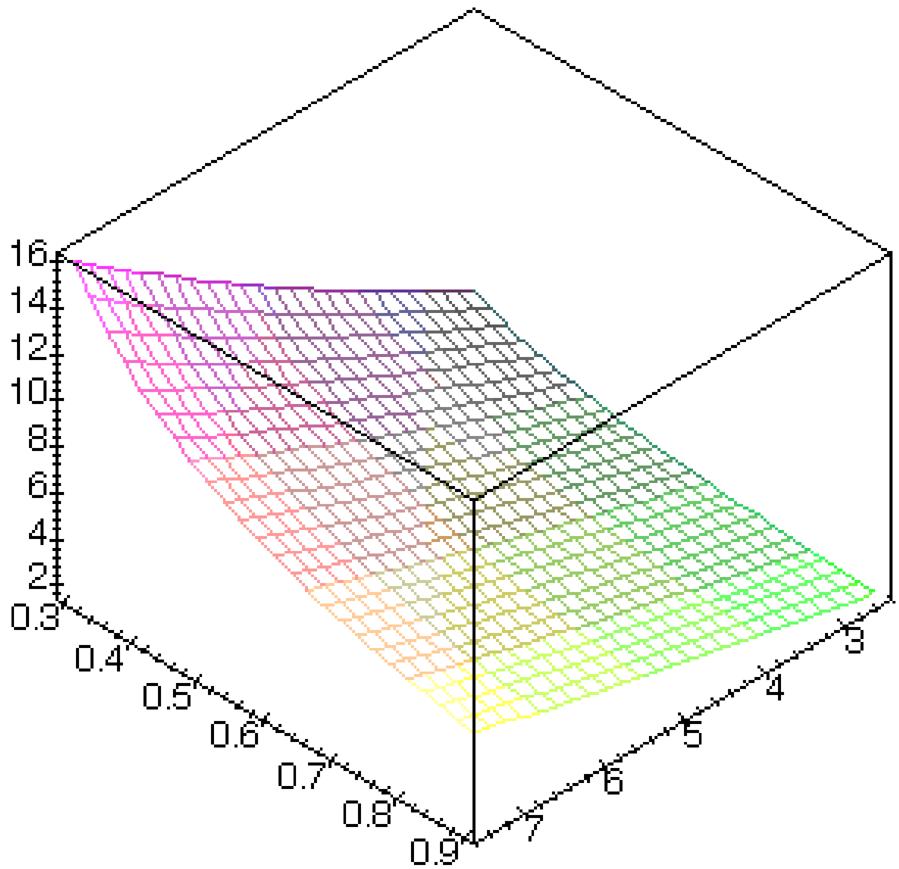

Figure 2b: Unemployment, Effort Levels and Detection Rates

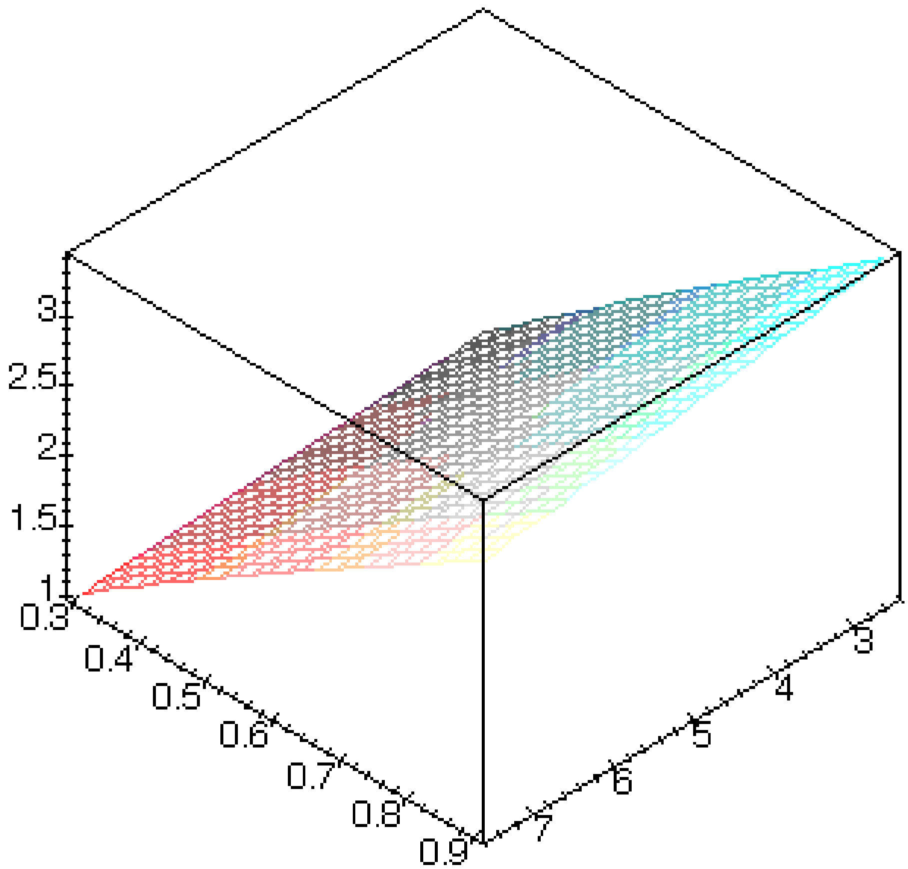

Figure 2c: Reputation Costs, Effort Levels and Detection Rates

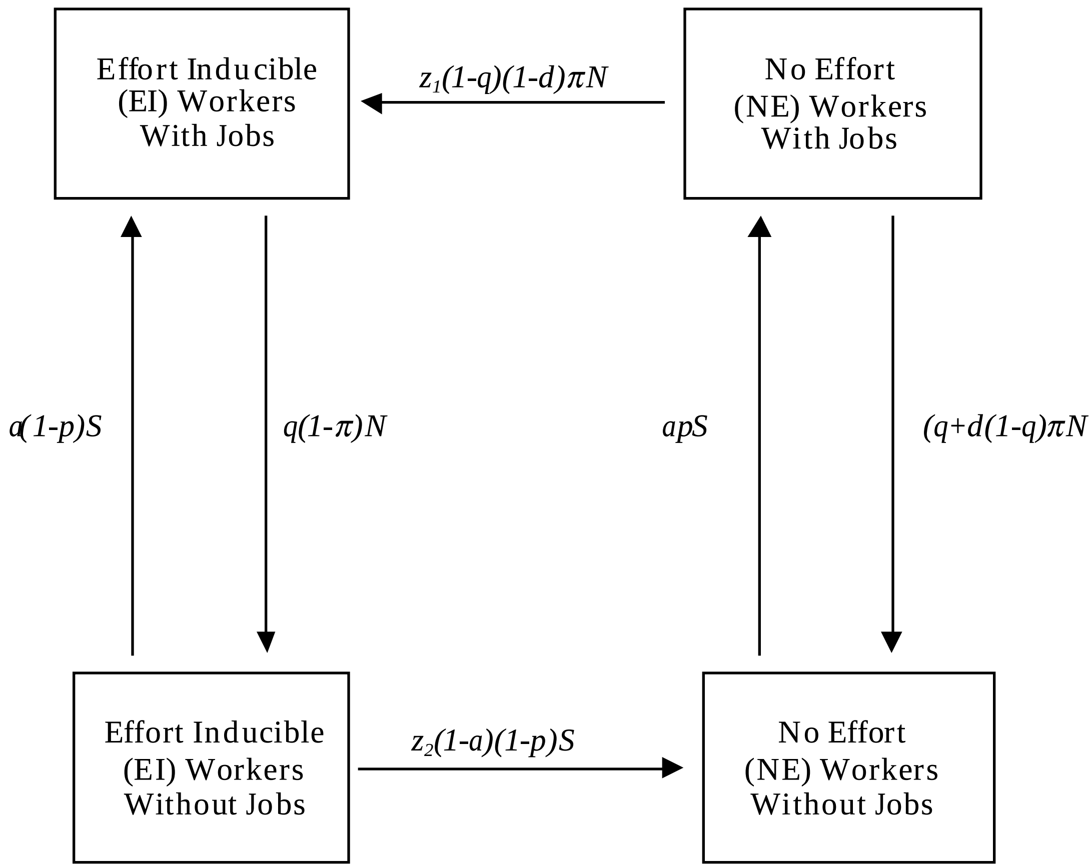

Figure 3: Labor Market Flows in the Modified Model

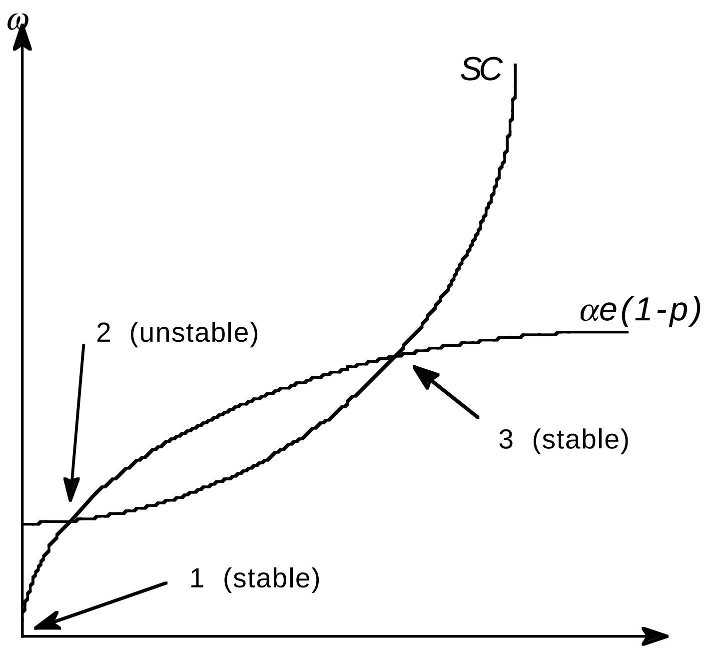

Figure 4a: Multiple Equilibria when the Number of NE Workers is Endogenous

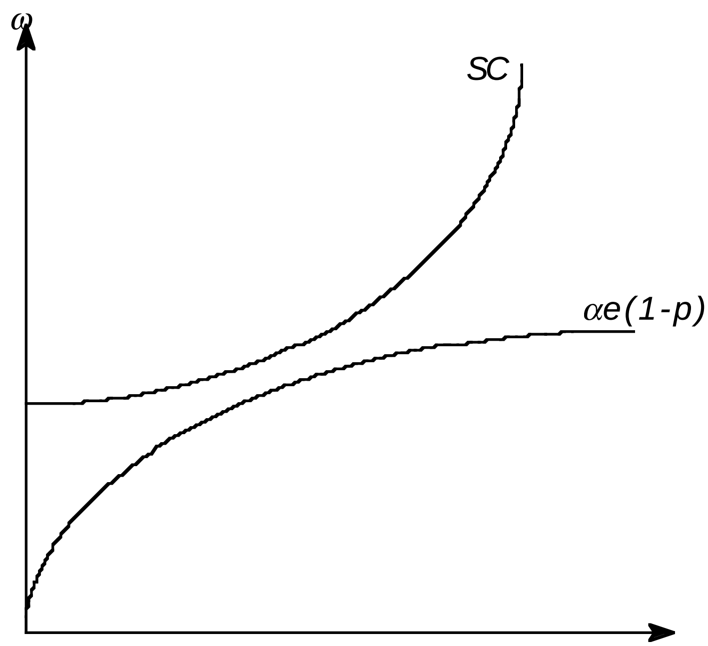

Figure 4b: A Collapsed Labor Market when the Number of NE Workers is Endogenous

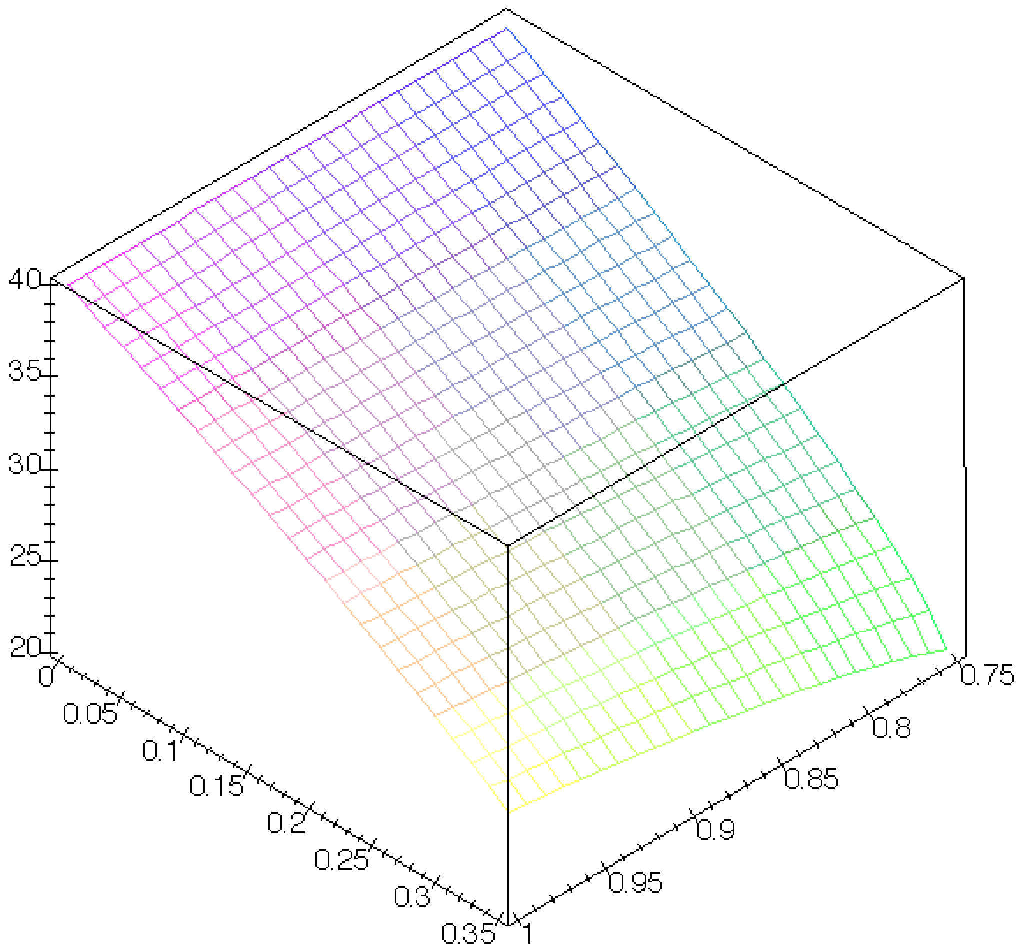

Figure 5a: Real Wages

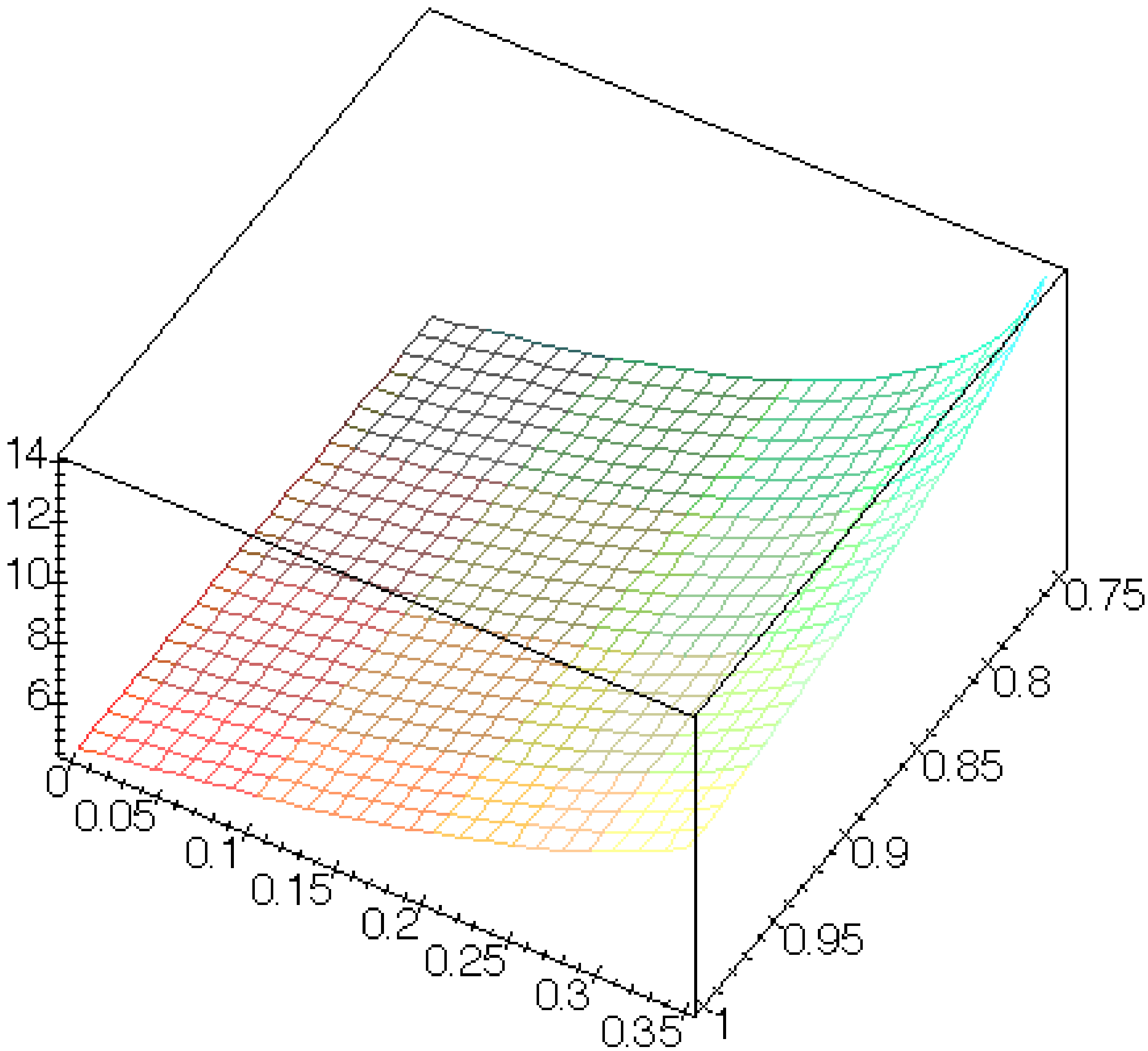

Figure 5b: Unemployment Rates

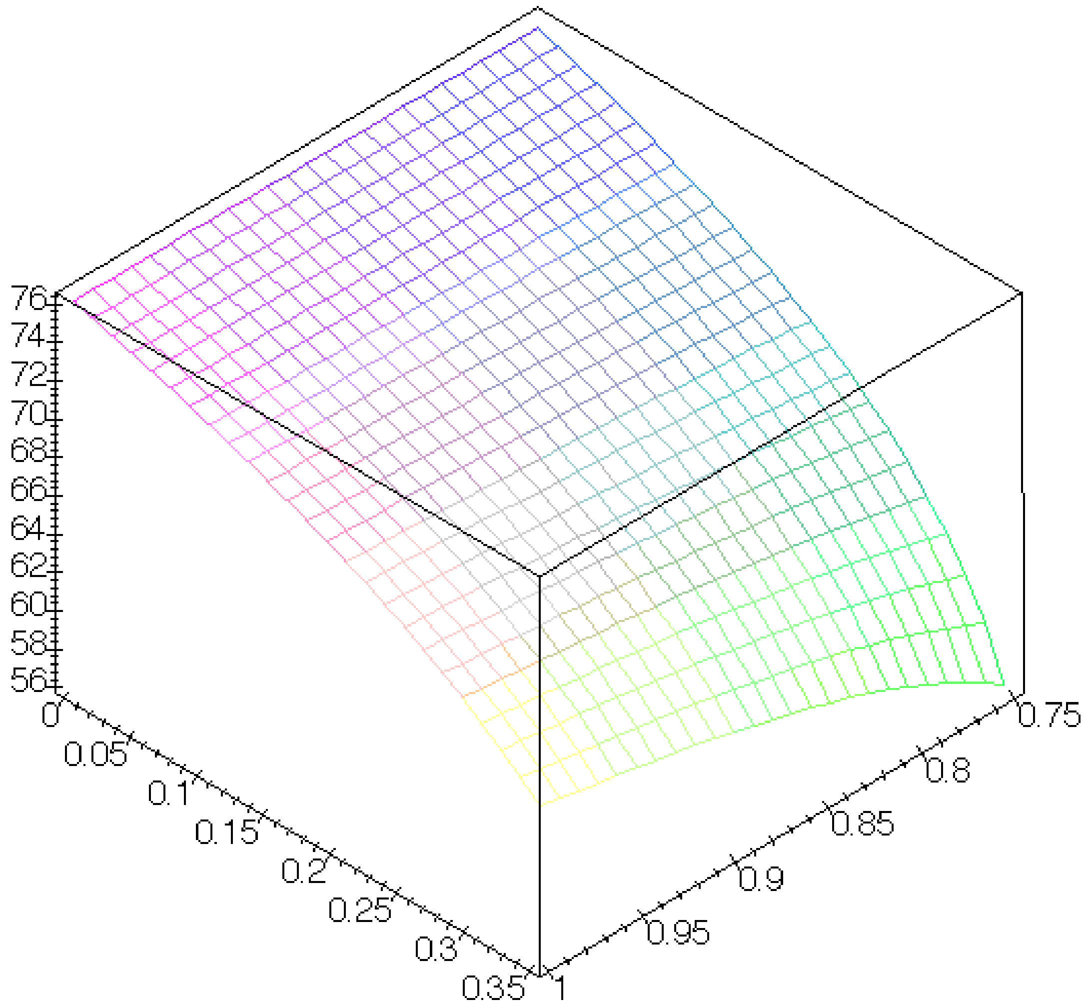

Figure 5c: Likelihood of Rehire

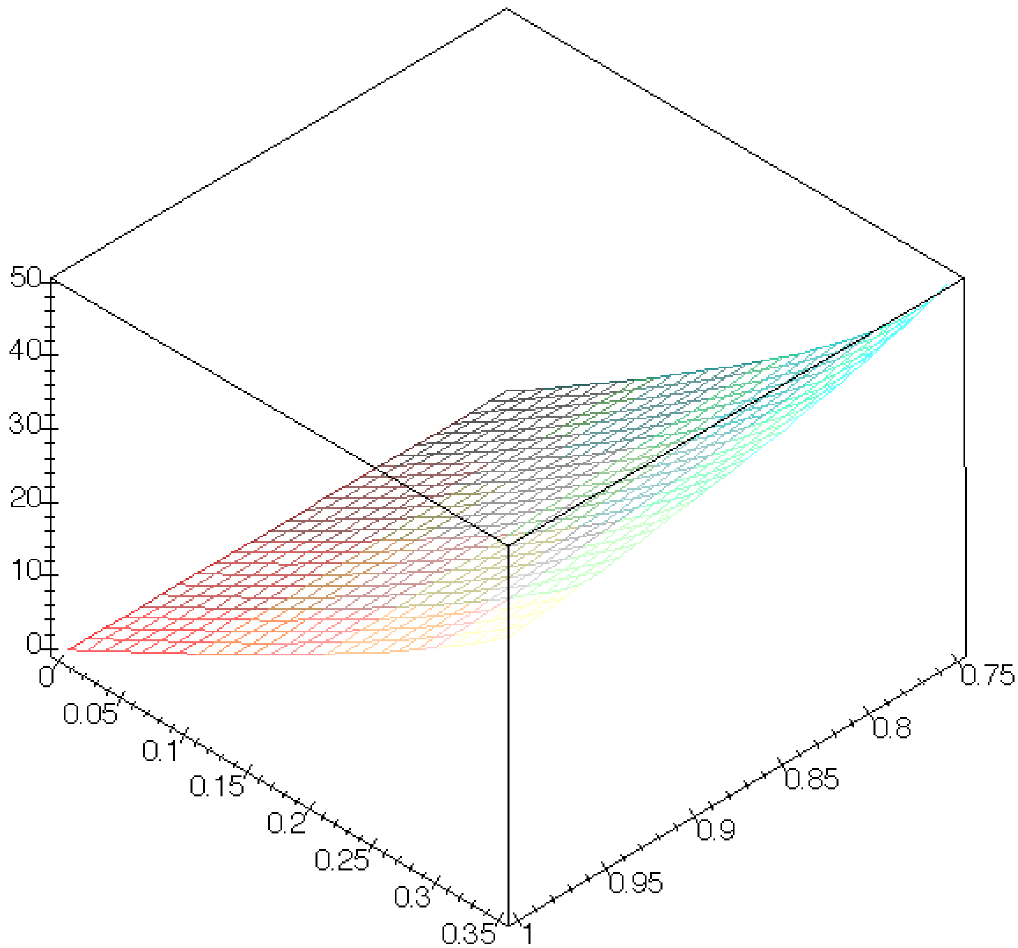

Figure 5d: Proportion of Jobless Who Are NE

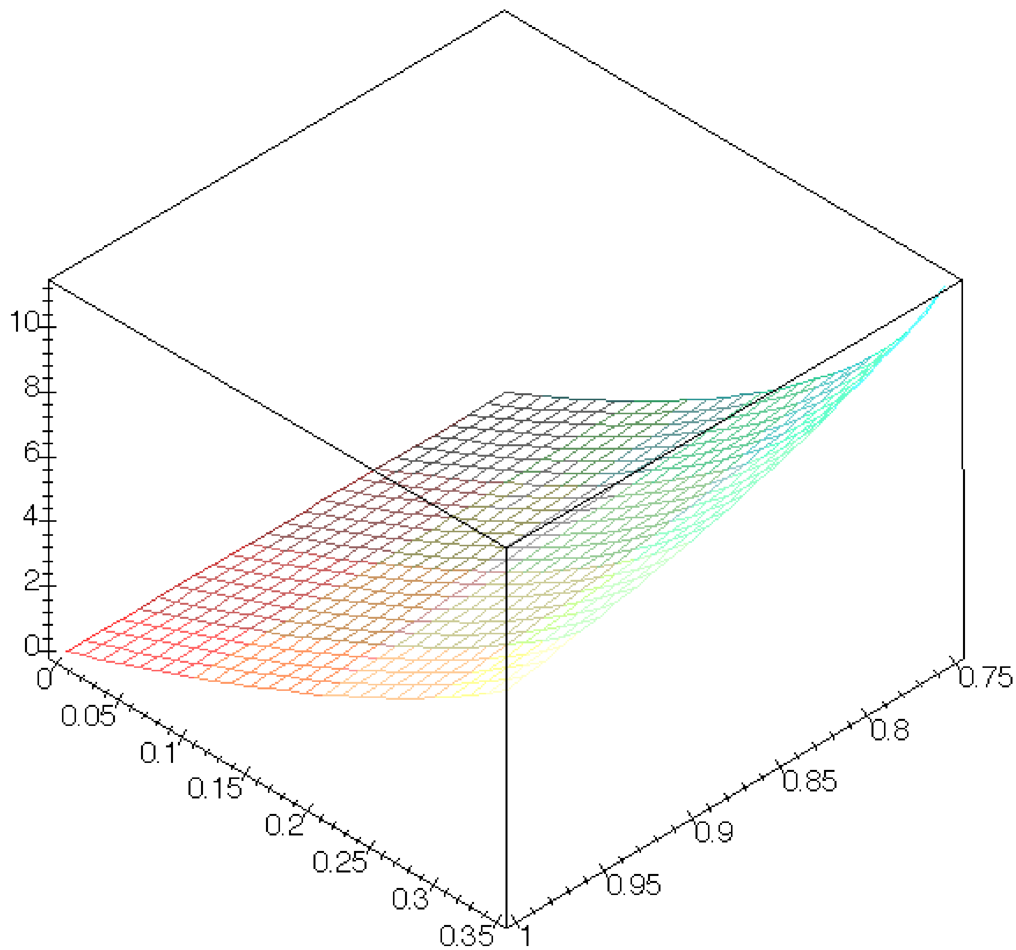

Figure 5e: Proportion of Those Employed Who Are NE

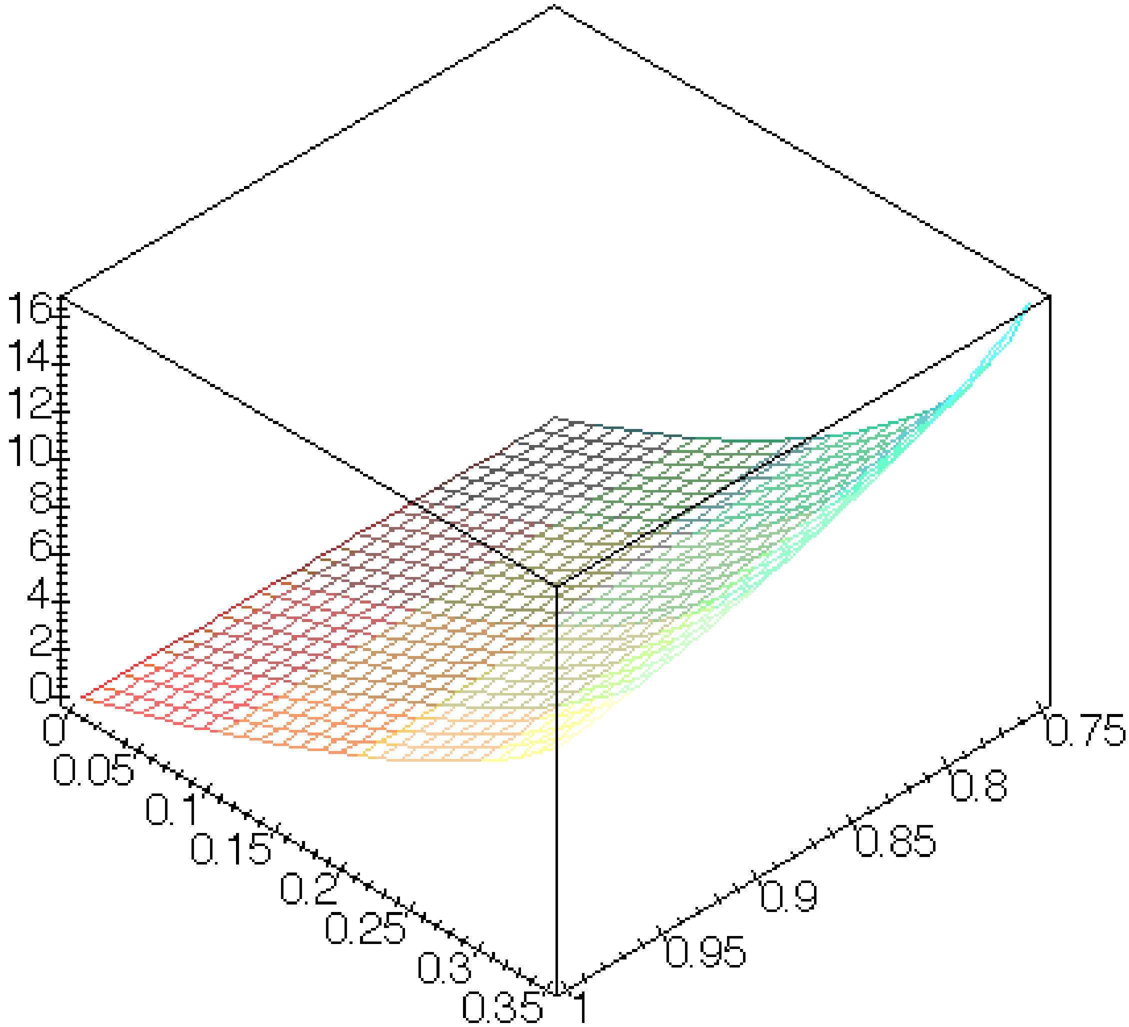

Figure 5f: Proportion of Labor Force That Is NE

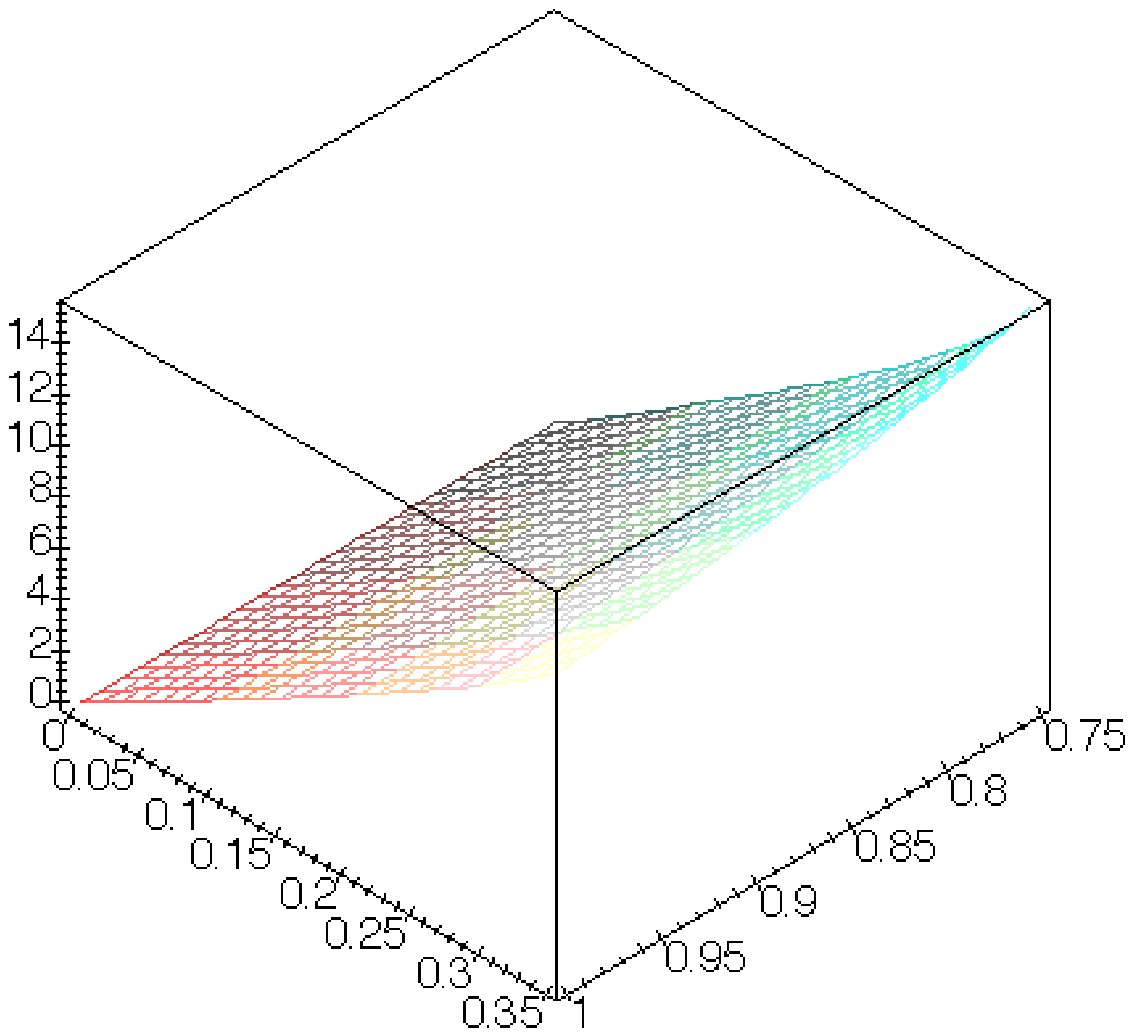

Figure 5g: Reputation Cost of Job Loss

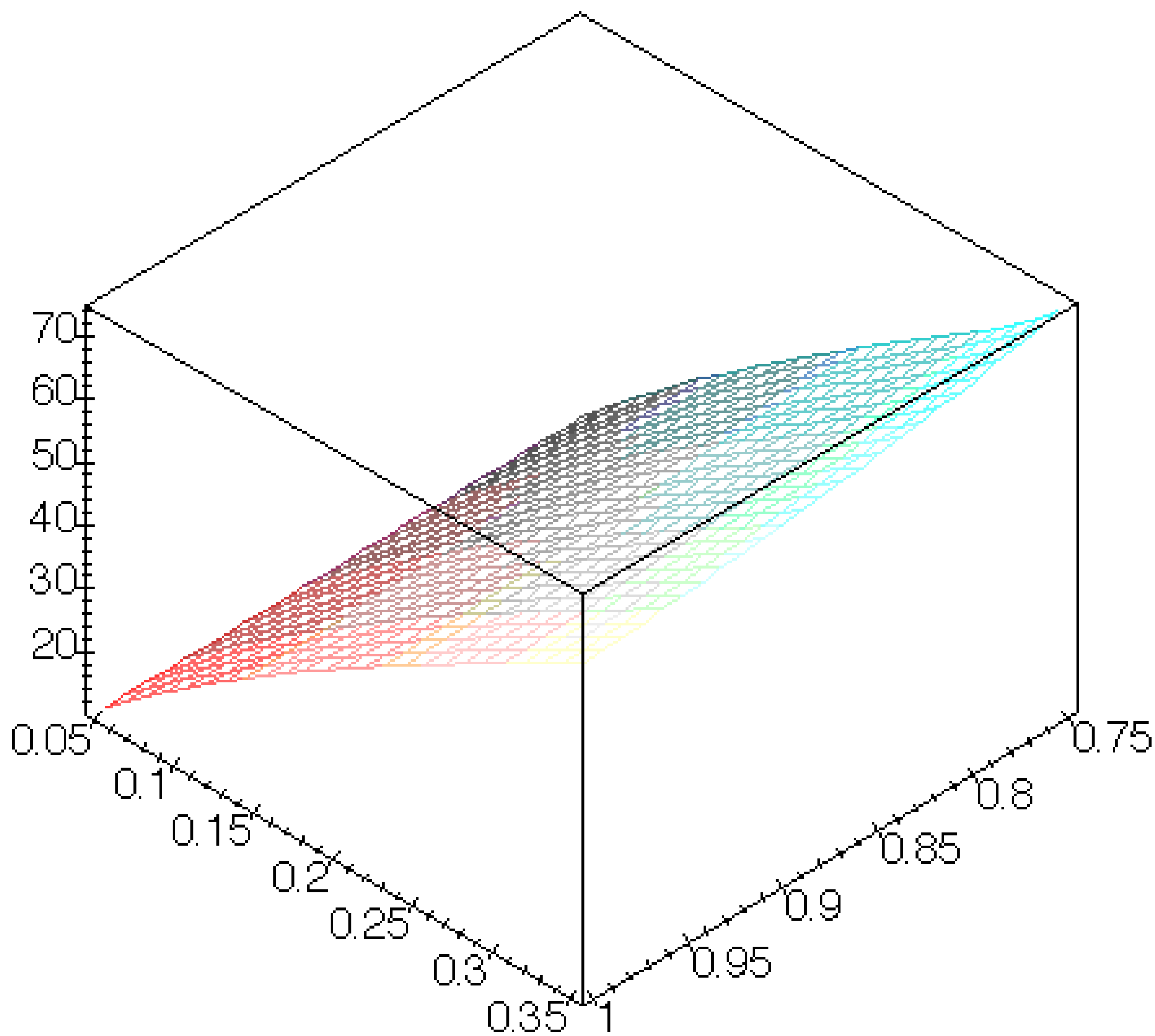

Figure 6: Threshold Employment Rates